breeze, is the presence of mountain slopes as was pointed out by Ferrel in his "Popular Treatise on the Winds," art. 132, 134, 136:

> 132. The strength of the monsoon, or of the land and sea breeze, depends very much upon the nature of the surface of the continent. In the case of a perfectly flat continent, with no highlands or mountain ranges, there would, of course, be an interchange of air between it and the ocean in case of difference of temperature; that of the lower part moving toward the warmer region and that of the upper part away from it; but the monsoon effects would be comparatively small, and would not at all have the great strength of surface which is usually observed. The interchange would be mostly in the great mass of air above, and no strong motion would take place at the earth's surface. In this case, also, the land and sea breezes have but little strength and are felt near the coasts only, but they are very much increased in strength and are felt at a much greater distance, where there are hill-sides and mountain slopes near the coast.
>
> In the annual and diurnal oscillations of temperature the amplitudes are small on the ocean surface and in the air at all altitudes above it, and also in the great mass of air over the continent, except in a stratum next the earth's surface, of small depth in comparison with that of the whole. The monsoon effects, therefore, depend mostly upon the temperature differences between the continent and the ocean of only a comparatively thin stratum of the atmosphere next the earth's surface, of which the part over the continent is very much heated above, or cooled below, that of the ocean. The temperature differences of such a stratum over a perfectly level continent, even if they were very great, would give rise to very little horizontal disturbance of the atmosphere. If this stratum over the continent were greatly heated, it might give rise to the unstable state from which would result numerous, but very small, local eruptions through the strata above, but no sensible monsoon effects. On the other hand, if it were cooled down to a very low temperature, the increased density would tend mostly to keep it next the earth's surface, and there would be scarcely any tendency to flow away laterally toward the warmer ocean. But if the surface of the continent is convex, or if it has highlands with long slopes, or the interior is in almost anyway considerably elevated above sea level, the tendency in the case of the summer monsoon to flow in from the ocean toward the interior of the continent, or the reverse in that of the winter monsoon, is very much increased. The same is true with regard to land and sea breezes where there are mountain elevations near the coast.
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> 134. There is also another consideration in connection with the subject of the monsoon influence of highlands. The tendency of air to ascend or descend and to give rise to ascending or descending currents depends upon differences of temperature between the air and that of the surrounding regions at the same level; but it is a matter of observation that the temperature of highlands, and especially of high plateaus, in summer, is nearly as great as that on plains near sea level. The temperature, also, for the altitudes above the surface, at least to a considerable height, must be much greater than that of the surrounding air at the same levels, since the rate of decrease of temperature with increase of altitude above the surface of the plateau is somewhat the same as above any plain near sea level. If a portion of air, therefore, either on a horizontal plane or a slope near sea level is only a little warmer than the surrounding air on the same level, it tends to ascend and to give rise to an ascending current; but if the air at this same temperature is high up on some mountain side or plateau, this tendency is much increased, because now the difference of temperature between this air and the surrounding air at a distance on the same level is much greater.
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> If a tall flue with a temperature only a little raised above the surrounding temperatures at sea level were elevated to the top of a high mountain, where the surrounding air is much colder and more dense, the draught of the flue would be very much increased. So the wide column of air of higher temperature over a high plateau and extending up to a considerable height above the surface has a much greater tendency to ascend than a similar one of the same temperature on a low plane near sea level.
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> This effect, however, is felt mostly in the summer monsoon influence, for in winter the temperature of the plateau is not so much below surrounding temperatures as it is above them in the summer.
>
> 136.—In the case of the summer monsoon, where the interior of the country is so elevated that the current ascends the slopes to an altitude where condensation of the vapor takes place, the latent heat of condensation adds much strength to the current, just as in the case of the trade winds, in which their strength is increased by the latent heat of condensation in the equatorial rain belt. On this account the summer monsoon of the North Indian Ocean is much stronger than the winter monsoon, so much so, that the southwest monsoon is often spoken of as "the monsoon," the northeast monsoon being insignificant in comparison with it. Notwithstanding that the (northeast) trade wind is combined with the monsoon effect, the resultant of both produces in the Arabian Sea only a gentle and steady breeze during the winter season; whereas the southwest monsoon of the summer is a steady gale of so great strength that it is impossible for even steamers to force a passage from Bombay to the Gulf of Aden in June and July.
>
> In all cases, also of extraordinarily strong sea breezes, there are high mountain elevations near the coast on which there is a vast amount of condensation and precipitation of rain at the time.

The differences of pressure observed on the earth's surface are largely dynamic results, depending on the motion of the air and the centrifugal forces that are evoked by that motion; the high and low barometric areas shown by our isobars are the results of movements in the atmosphere, but are not the direct cause. The ultimate cause of currents and winds must always be found in abnormal densities due, primarily, to the peculiarities in the distribution of temperature and moisture; in the free atmosphere the differences in density have a slight influence on the pressure, but the resulting motions give rise to the larger phenomena of our barometric areas. An increase of density in the tropical high areas off our Atlantic and Pacific coasts will cause them both to push southward; a diminution of density over the American continent will have the same tendency. An equal change in the densities of all three regions will produce no effect on their relative locations; the differential change is that which determines the wind and the overflow, and hence, the observed variations in the locations of these high and low areas. A high area does not push a low area but feeds it.

The southerly current in our Gulf States and the southeast winds on our Atlantic coast are far less steady and much shallower and drier than the southwest monsoon of India, and they proceed inward to a less distance, so that the rainfall depending upon them is correspondingly less. The rains that fall in the United States, both in summer and winter, east of the Rocky Mountains, are largely due to the underflow of cooler air that characterizes the southwest and southeast sides of cyclonic circulations, moving successively across the continent. Even the so-called local summer thunderstorms are often a part of such systems of underflow and uplift.

A long-range prediction as to the quantity and character of the rains during the summer time in the United States must depend upon the possibility of predicting (1) the position of the tropical area of high pressure that encroaches on our south Atlantic States, and (2) the flow of cold, dry air southward from the British possessions that occurs when the tropical high area off of our Pacific States retreats to the west of its average position so that the flow of warm, dry air that descends from it down the eastern Rocky Mountain slope is at a minimum.

Probabilities as to rainfall may be computed from statistics, but a rational prediction must be based on the above mechanical considerations.

AN ITEM IN THE EARLY HISTORY OF WEATHER TELEGRAPHY.

In 1844 (May 27) the Morse system of electro-magnetic telegraph was first put into operation between Baltimore and New York, and it is said that but a few days had elapsed before the operators at either end, in their familiar conversation with each other, began to interchange remarks about the weather and could sometimes forewarn each other of the more important changes. Of course, in those days, as now, the weather, especially the storms, was a matter of news for the daily papers. In 1846, W. C. Redfield, of New York, who had, for twenty-five years, been mapping and studying the progress of storms, published the following sentence in the American Journal of Science and Arts, Vol. II, p. 334:

> In the Atlantic ports of the United States, the approach of a gale, when the storm is yet on the Gulf of Mexico, or in the Southern or Western States, may be made known by means of the electric telegraph, which probably will soon extend from Maine to the Mississippi. This will enable the merchant to avoid exposing his vessel to a furious

gale soon after leaving her port. By awaiting the arrival of a storm and promptly putting to sea with its closing winds, a good offing and rapid progress will be secured by the voyager.

In the Second Annual Report of the Board of Regents of the Smithsonian Institution (Senate Mis. No. 23, Thirtieth Congress, first session, Jan. 6, 1848), showing the operations of that institution for the year 1847, the secretary, Prof. Joseph Henry, indorses, under date of December 8, 1847 (p. 190), and (pp. 193–208) publishes letters from Professor Loomis, of New York University, and Professor Espy, of Washington, explaining in the words of Professor Loomis, that—

When the magnetic telegraph is extended from New York to New Orleans and St. Louis it may be made subservient to the protection of our commerce, even in the present imperfect state of our knowledge of storms. * * * Let a meteorological department of the institution be organized under the direction of its secretary with a suitable assistant. * * * Let it be the duty of the meteorologist to take charge of the observations, to discuss and analyze them, and endeavor to deduce from them the laws of storms. Let these investigations be published with as much detail as may be thought to be demanded by the claims of science, etc.

Similar ideas were advocated in the letter from Espy, who, however, gave more prominence to the study of the physics of the atmosphere. This idea of predicting the motions of storms had, in fact, been uppermost in the lectures of Loomis at Western Reserve College, Ohio, and Espy at Philadelphia, for years before. The above sentence from Redfield's memoir laid stress on the prediction for the benefit of commerce. Some enterprising practical men seemed, however, not willing to wait for the action of the Federal Government or of the scientists who were advising Professor Henry. The latter contemplated establishing new meteorological stations and the study of the weather maps that might be compiled from their records as preliminary to predictions. But the young men of New York were in haste to realize the benefits of storm warnings before the scientists had become acquainted thoroughly with the laws of their movements. The Smithsonian scheme for new studies went into operation in November, 1848, by the issue of a circular to observers. The subsequent steady development of its system of telegraphic reports culminated in the daily map that began, I think, in 1855; but before this a very remarkable enterprise was undertaken by a news agency in New York City, which is best described in the terms of the advertisement published in Silliman's American Journal of Science (2), Vol. V, No. 14, for March, 1848, as follows:

NEW YORK, *January* 24, 1848.

To Colleges, Universities, and other Public Institutions:

The undersigned beg leave to state that they have made extensive arrangements for *telegraphic reporting*, and have correspondents located in all the principal cities and towns of the United States, and they are in the habit of transmitting daily all news of interest.

They, therefore, respectfully propose to supply public institutions with daily *meteorological* reports from all the principal towns of the country, giving the state of the thermometer and barometer at any specified time or hours of the day, which would not fail in extending the utility of meteorological observations and greatly aid in illustrating the peculiarities of the climate of the United States.

Each institution disposed to encourage the enterprise will be served with daily copies on the most reasonable terms. Should a sufficient number come into the arrangement to justify the expense, the reports can probably be supplied at about from 12½ to 25 cents per day, from each city.

The patronage of your institution is respectfully solicited.

We have the honor to be, your very obedient servants,

JONES & Co.

References.—They respectfully refer to the editors of the Journal of Commerce and Courier and Enquirer and to Prof. S. F. B. Morse.

J. & CO.

38 William street, Merchants' Exchange.

In commenting on the above advertisement, the editors of the American Journal of Science and Arts remark as follows (2), Vol. V, p. 297:

Telegraphic reports of meteorological phenomena.—Messrs. Jones & Co., Merchants Exchange, New York, have made arrangements to give daily and hourly reports of meteorological phenomena, by telegraphic messages from all parts of the country which are in telegraphic communication with New York. This novel and important enterprise will furnish more extensive means of synchronous comparison of the state of the barometer, direction of the wind, and, generally, of all meteorological phenomena than were ever before possessed by the scientific world. It is hoped the colleges, scientific institutions, and individuals favorably situated will combine their efforts to give efficiency to this scheme, which, if properly encouraged by proper hands, can not fail of interesting results.

We refer to the advertisement of Messrs. Jones on our advertising sheet.

The Editor of the WEATHER REVIEW would be glad to hear from the older observers of the service or anyone who knows anything more about the work done by these enterprising journalists of 1848. He would appreciate an examination of any old newspapers or other periodicals containing notes of interest to the historian of meteorology in this country.

METEOROLOGICAL TABLES.

By A. J. HENRY, Chief of Division of Records and Meteorological Data.

Table I gives, for about 130 Weather Bureau stations making two observations daily and for about 20 others making only the 8 p. m. observation, the data ordinarily needed for climatological studies, viz, the monthly mean pressure, the monthly means and extremes of temperature, the average conditions as to moisture, cloudiness, movement of the wind, and the departures from normals in the case of pressure, temperature, and precipitation.

Table II gives, for about 2,400 stations occupied by voluntary observers, the extreme maximum and minimum temperatures, the mean temperature deduced from the average of all the daily maxima and minima, or other readings, as indicated by the numeral following the name of the station; the total monthly precipitation, and the total depth in inches of any snow that may have fallen. When the spaces in the snow column are left blank it indicates that no snow has fallen, but when it is possible that there may have been snow of which no record has been made, that fact is indicated by leaders, thus (....).

Table III gives, for about 30 Canadian stations, the mean pressure, mean temperature, total precipitation, prevailing wind, and the respective departures from normal values. Reports from Newfoundland and Bermuda are included in this table for convenience of tabulation.

Table IV gives, for 82 stations, the mean hourly temperatures deduced from thermographs of the well-known pattern manufactured by Richard Bros., Paris, described and figured in the Report of the Chief of the Weather Bureau, 1891–'92, p. 29.

Table V gives, for 67 stations, the mean hourly pressures as automatically registered by barographs of the pattern manufactured by Richard Bros., Paris, except for Washington, D. C., where Foreman's barograph is in use. Both instruments are described in the Report of the Chief of the Weather Bureau, 1891–'92, pp. 26 and 30.

Table VI gives, for 136 stations, the arithmetical means of the hourly movements of the wind ending with the respective hours, as registered automatically by the Robinson anemometer, in conjunction with an electrical recording mechanism, described and illustrated in the Report of the Chief of the Weather Bureau, 1891–'92, p. 19.